RESULTS OF RESEARCH PROJECT ON DEVELOPMENT OF OPTICAL AIDS FOR THE PARTIALLY SIGHTED

[illegible]

[illegible]

[illegible]

[illegible] considered as conjunct- [illegible]

Research [illegible]

[illegible] summer of 195[illegible]

Brief [illegible] a brief [illegible] detective investigation [illegible] experience [illegible] similar study. It [illegible] receive the assignment through [illegible] intensive schedule [illegible]

Dr. O'Brien [illegible] administration [illegible]

[illegible] Prosthetic, Prosthetic and Sensory Aids Service, Veterans Administration.

Special thanks are due to Dr. J. Last, Chief Ophthalmologist in the New York Regional Office, Veterans Administration. He and his fellow ophthalmologists, Dr. H.F. Mayer and Dr. J. Weinstein, contributed in every effort possible to select patients, protect them against possible harm, and to insure validity.

The following list of persons and their staffs also gave valuable assistance and consultation:

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[illegible] SUMMARY

During the spring of 1950, the Institute of Optics, University of Rochester, under contract to the Veterans Administration, conducted an evaluation of twenty-one optical devices designed to aid the partially sighted. The evaluation was made at the New York Regional Office of the Veterans Administration.

The subjects were all partially sighted veterans from the Metropolitan New York City area whose disability was service connected. Each of the forty-four subjects in the experimental group was given an eye examination by an opthalmologist who also explored the veteran's medical and psychiatric history to eliminate emotionally unstable persons. Subjects for the most part were those whose visual acuity in one eye or both was found to be 20/200 or less.

Optical magnifiers evaluated were obtained from the University of Rochester, Engineering Development Corporation, Perkins Institution, Franklin Institute, and other agencies; and there were twenty-one in all. All reading aids were of low magnification.

From an evaluation of these devices, the following conclusions emerge:

1. No one reading device seems entirely satisfactory for the majority of the subjects.

2. Telescopic spectacles as tested here, without individual fitting of lenses are apparently unsuitable for reading when used by persons with visual acuity of 20/200 or less.

[illegible] magnifiers which provide [illegible] with one eye for monocular vision, and the balance of the experimental group tends to depend on the latter sort. In consequence, about 50 per cent may be expected to accept a monocular direct-view magnifier if its other features are attractive.

4. For many an intensely-illuminated field of view is important. There is a preference for reading devices which are self-illuminating. There is rather wide-spread dislike among the subjects for fluorescent tube lighting.

5. The median of choice of power of magnification for direct-view magnifiers seems to be about 3X. Combined with the widest yet reasonably clear visual field compatible, this feature should set the limits for the design of the optical system. For another group of individuals, 5X should be available, even though width of field must be sacrificed.

6. Design, development, and testing of a portable magnifier combining the features found best in this study seems technically possible.

INTRODUCTION

This investigation was made by the Institute of Optics, University of Rochester, for and with the cooperation of the Veterans Administration. The study is intended to supplement work already done towards solving the reading problems of the partially sighted; hence it has relied heavily upon those works. The purpose of the study is to determine the usefulness of low-power direct-view magnifiers[1] as reading aids to veterans with visual acuity[2] of 20/200 or less. (Veterans with 20/200 visual acuity in both eyes are considered to have lost 80% of their visual efficiency and are entitled to 100% disability benefits under Public Law 309, when such a loss is service-connected.)

V.J. Ellerbrock, formerly of the Research Division of the Dartmouth Eye Institute, submitted a "Report on Survey of Optic Aids for Subnormal Vision" to the Committee on Sensory Aids, The Office of Scientific Research and Development, November 15, 1945. The range of vision covered was set as 20/70 to 20/200 Snellen inclusive.

The survey covers and lists a bibliography, that "includes only those articles which have been published from 1910 to the present time, (November, 1945) and the readers who desire to study the publication of the contributions before 1910, should consult the articles by [illegible] entitled 'Die Entwicklung der Fernrohrbrille'."

The findings of that report pave the [illegible] or any subsequent study made on the subject. Fortunately, several authorities of related fields

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1. See Description of Magnifiers

2. See Discussion of Acuity

[illegible] Perkins [illegible] 1947 [illegible] assessed to [illegible] relative comparison among the [illegible] devices. The devices tested included both direct-view [illegible] and screen or projection types. This study has benefitted greatly by the information given in these reports.

It is necessary to explore the usefulness of other types of visual aids while determining the usefulness of low-power direct-view magnifiers. The exploration need not be made on an absolutely comparative basis, but should be thorough enough to avoid giving the appearance of being oblivious to their existence.

Within the scope of this study, it is proper to accord that recognition to projection type reading devices and telescopic spectacles. This does not imply competition among the three types of devices, because each device, even in the present state of development, has a definite and unique place among the optical aids for the partially-sighted.

The usefulness of direct-view type reading devices will be determined in this study by giving as much attention to the effects of illumination and other necessary appurtenances as to the effects of magnification and the clearness of the field. It is thought to be equally as important to learn about the tolerance of gadgets for convenience as to learn about required magnification.

Procedure

The experimental plan for conducting these tests required the assembling of reading devices of relatively low magnifying power with emphasis on the direct vision lens type, the procurement of a reading-test room with adequate lighting and comfortable chairs and tables, the preparation of suitable reading-test materials, and the procurement of at least forty partially sighted subjects most of whom had visual acuity of 20/200 or less.

There were twenty or more kinds of optical devices collected in a store room at the New York Regional Office of the Veterans Administration when the project officially began on April 1st, 1950. Some were duplicates and a few others proved unsuitable for one reason or another.

There were also numerous reading devices at Perkins Institution that were selected for use in this study. Other supplementary optical reading devices were sent from the University of Rochester, Rochester, N.Y., Engineering Developments, Inc., Portsmouth, R.I., and the Franklin Institute, Philadelphia, Pa.

The complete list and a description of each of the 20 magnifying reading devices used in the tests follow:

[illegible]

Plate A

No. 1 - A [illegible] convex spherical lens, 3 inches focal length, 3.5 inches diameter. Mounted in a [illegible] to a 5/[illegible] [illegible]

handle [illegible] inches long, [illegible] fittings to locate and tighten metal lens.

Magnification, as used, about [illegible] diameters.

No. 2 - R [illegible] A double convex spherical lens, 5 inches focal length. [illegible] 2 by 7 inches in order to reduce marginal [illegible]. Mounted in a [illegible] mounted Zenith holder, with one [illegible] inch arm, [illegible] inch wide, also a handle 4 inches long, at [illegible] angle [illegible] at a 30° angle to normal.

Magnification, as used, about [illegible] diameters.

No. 3 - [illegible] convex [illegible] lens, [illegible] inches focal length, 4.5 inches diameter. [illegible] mounted in a [illegible] band and wooden handle [illegible] No. 1.

Magnification, as used, about [illegible] diameters.

No. 4 - A double convex spherical lens, [illegible] 3.[illegible] inches focal length, 5 inches diameter, held for use by [illegible] wooden handle similar to that of No. 1.

Magnification, as used, about [illegible] diameters.

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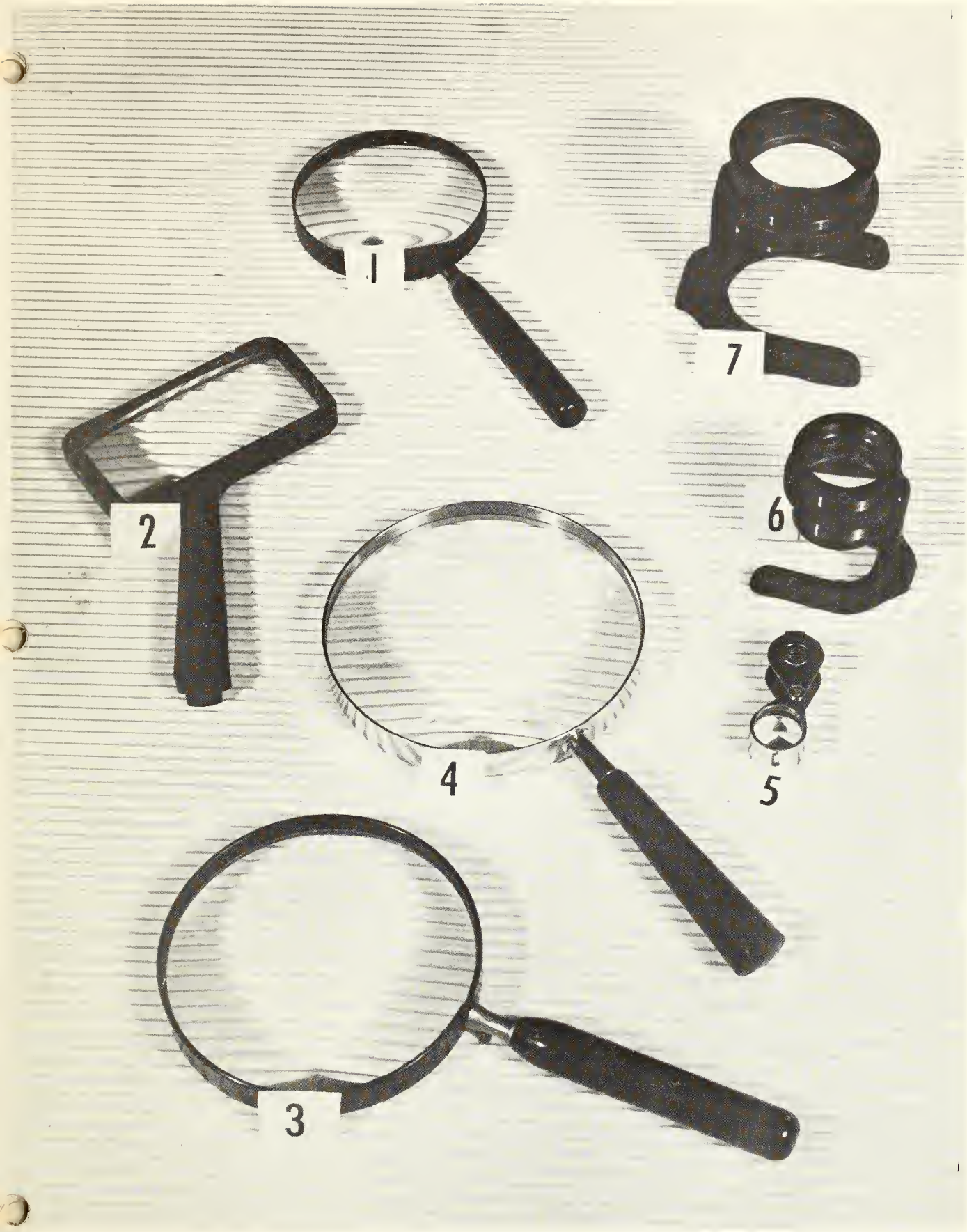
1 Manufactured by Bausch & Lomb Optical Co., U.S.A.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5
6
7

square which has [illegible] inches as overall dimensions including directions for using [illegible] It is recommended for chromatic and spherical aberration. Its S & A trademark label discloses manufacture in Boston, Mass. Magnification about 6 diameters.

No. 6 - B.& L.[1] A utility type doublet which screws up and down in a metal frame on a horseshoe base, finished in black crackle. The lens system has a flat and sharply defined field, corrections on the objective for achromatism and curvature of field. The focal length is 2.2 inches, diameter of lens 1.4 inches.

Magnification about 4.5 diameters.

No. 7 - B. & L.[1] Similar to No. 6 except in specification for lenses, the focal length of the combination is 2.75 inches, diameter of lens 2.0 inches.

Magnification about 3.5 diameters.

PLATE II

No. 8 - B. & L.[1] A symmetrical doublet composed of two thin and equal plano-convex lenses, 6.3 inches focal length, 1.8 inches in diameter; their convex surfaces face each other and are separated by a space of ½ inch. The combination has a focal length of 3.15 inches and is mounted in a two-piece moulded black Venite holder.

Magnification about 3.0 diameters.

No. 9 - B. & L.[1] An identical optical system with No. 7 but mounted on a heavy cast iron base. It has a six inch arm with pivotal motion about a horizontal axis at the base, and a universal ball and socket attachment to a ring at the other end. The ring supports the metal frame mount which has screw motion for sharp focusing.


11
12
10
8
9

[illegible] about [illegible] power magnification [illegible] close enough to appear about half of their actual distance, and The reading frame for the lenses is of light metal, fitted with flexible wire handles, threads and screws for holding lenses in place, changing intermediate space and for focusing.

No. 11 - A 4-element reading glass, specially designed and constructed to eliminate spherical and chromatic aberration for a subnormal vision project by the University of Rochester, Institute of Optics. Focal length of the optical combination 7.0 inches. It has a chromium and gray crackle finish. Magnification, as used, about 2.0 diameters.

No. 12 - The identical lens of No. 2 using the identical mount and base of No. 9.
Magnification, as used, about 1.4 diameters.

PLATE III.

No. 13 - A reading device built by Stocker and Yale Corp., Marblehead, Mass. It has a rectangular cut spherical lens 1 ¾ by 2 ½ inches, with a 6.7 inch focal length. Mounted with two 4 watt fluorescent lights in a rectangular reflector with an inside finish of white enamel and an outside finish of black crackle. The apparatus is supported on a 4 inch circular cast iron base with a black crackle finish. A 9 inch chrome finished arm, bends into thirds about two horizontal axis, has a pivot attachment at each end.
Magnification, as used, about 1.5 diameters.


15
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6 ELECTRICALLY HEATED EXTRUDER ACCLAIMED IDEAL FOR PELLETIZING: ALL OTHER PROCESSES
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14
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Some U.S. Aides Said to Seek Strachey's Ouster in Britain
SENATORS TO DECIDE TODAY ON SUBPOENA FOR LATTIMORE FILE
Red Inquiry Subcommittee Is Interested in McCarthy's Papers on Professor
HICKENLOOPER IN DISSENT
Wisconsin Republican Calls a 'Quite Important' Press Parley This Morning
4 EX-FELONS SEIZED AS HOLD-UP GANG
ADENAUER ADVISES
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Any well set advertisement may do
Any well set advertise
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tisement may do!
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[illegible]

[illegible] Magnifier Developed [illegible] the Perkins Institute of [illegible] Fiber Jacket magnifier [illegible] 1.05. It is described in the literature as having [illegible] plate [illegible] focal length of [illegible] inches and a diameter of [illegible] inches. It uses a 12 watt tungsten fluorescent tube which gives an illumination of [illegible] foot candles or approximately daylight quality, (color temperature 3,000° K.) without screens.

The lens is mounted in a glass [illegible] in the center of a circular fluorescent tube by a transparent [illegible] plastic corrector. A [illegible] lamp, with a black reflector [illegible], supports the lens and reflector-shield in front of a [illegible] "window" [illegible] fluorescent [illegible] in its center.

Magnification [illegible] about 1.4 diameters.

No. 2: A magnification device [illegible] the Perkins Institution. It has the appearance of either a [illegible] and pressed fiber boards, [illegible] x [illegible] x 5 inches. It has a ground glass screen [illegible] 6½ x 4 3/4 inches at one end, and a 2½ inch thick Cleveland plate glass at the other. The lens is an [illegible] achromat of 7 inch focal length. It was fitted between the plate glass and screen at a distance of 2½ inches from the outside surface of the plate glass, and 11 inches from the screen.

Magnification of this device is 4.0 diameters.

The Perkins Institution Projector is not a finished, convenient model for a reader to operate by himself. But utilizes a principle

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Any well set ad ve
rtisement may do
Any well set ad
vertisement m1

[illegible] and all [illegible] [illegible] used consistently [illegible] has been [illegible] very well in spite of its [illegible] [illegible].

Several [illegible] were [illegible] at [illegible] June [illegible], [illegible] at Franklin Institute, [illegible], Pennsylvania. [illegible] the [illegible] [illegible] of the [illegible] [illegible] of [illegible] at the [illegible] [illegible] or recommendations [illegible] [illegible] [illegible] at that time, however, questions about [illegible] [illegible] [illegible] asked by interested individuals.

We were shown the [illegible] type [illegible] developed by the Franklin Institute. This [illegible] [illegible] compact [illegible] overall measurements [illegible] x [illegible] x [illegible] [illegible] [illegible] door, [illegible] [illegible] of [illegible] and [illegible] magnification [illegible] the inclined [illegible] x [illegible] [illegible] [illegible] [illegible] [illegible] of a strip of [illegible] [illegible] [illegible] column of a newspaper or magazine. The [illegible] [illegible] [illegible] top [illegible]. It [illegible] by [illegible] [illegible] by [illegible] a [illegible] the frame designed to [illegible] a bottle.

[illegible]

[illegible]

[illegible] foot-candles [illegible] meter.

All magnifying devices were [illegible] showed greater contrast between the [illegible] lighting [illegible].

[illegible] magnifiers [illegible] from 15 to 3, and each, except No. 17, illuminated the printed page at 20-30 foot-candles. Illumination from No. 17 was 200-250 foot-candles. All light intensities discussed were based on [illegible]° K. average over the whole spread of an instrument calibrated as a true illumination meter.

[illegible]

[illegible] reading [illegible]

[illegible] that [illegible]

[illegible] or [illegible]

The reading [illegible] magazines, popular [illegible] type-written [illegible] on pages of advertisements [illegible] paper publications. [illegible] of these samples [illegible] form and a half [illegible] of cardboard, 5 x 12 [illegible] visible in the photographs of the magnifier.

In addition there [illegible] glass finish cards on which were printed [illegible] lines [illegible] type in

each of the following sizes [illegible] and [illegible] type. A standard type book, with [illegible] as usual [illegible] 72-points, was also employed. [illegible] type sizes, it may be stated that the [illegible] on the point system. The point [illegible] 10-point type is 10/72 and 12 point type is [illegible]

Section II

Subjects

The decision to [illegible] to get some [illegible] the [illegible] number that would be required, and the [illegible] involved much consideration. It seemed necessary to [illegible] a difference in attitude toward a handicap of vision between persons born with poor vision and those who had acquired the disability as adults after having experienced normal or nearly normal vision in both eyes. Our purpose favored the latter.

The outcome of these considerations was a decision to use the roster of service-connected blind persons in the files of the Veterans Administration as a source to get forty or more subjects. A check of the files showed that fifty persons lived in Greater New York City who had the characteristics of suitable subjects. The majority lived in Manhattan, most of the others lived in the Bronx, Brooklyn, and Queens.

Letters announcing the existence of the new project, its aims and purpose were sent to those veterans.

They were invited to participate and give opinions on merits or demerits of the devices. Five of the candidates had left the immediate environs of New York City and were therefore not available. Eighty per cent of the remainder made it possible to present themselves for the study. The balance were recruited among the partially-sighted veterans who were technically service-connected for other disabilities and had returned for their regular periodic physical checkup.

Persons familiar with the results from initial mill contacts for projects of this type will realize the unusually favorable response in this case.

[illegible]

[illegible] the number of [illegible] enough to render t[illegible] 1 [illegible] size of a newspaper [illegible]

In [illegible] rea[illegible] subjective [illegible] the [illegible] scaling of [illegible], the a[illegible] jobs. He could [illegible] based on the following [illegible]

1 means no readi[illegible]

2 means no readi[illegible] of [illegible]

3 means no readi[illegible]

4 means hard to [illegible] of all single [illegible]

5 means fairly s[illegible] [illegible] valu[illegible]

The interviewer pl[illegible] the reader's performance [illegible] the reader's preferences for a first and second [illegible] magnifier.

TABLE I

CASE	ACUITY DECREASING TEST EYE	AGE	MAGNIFIERS INCREASING -- POWER -- 1 1.5	2 1.4	12 1.4	3 1.4	4 1.3	10 1.8	11 2.0	13 1.5	15 1.5	16 2.3	17 2.0	18 2.5
29	+ 20/20	64	4	4	4	4	4	2	4	4	4	4	4	4
19	= 20/40	36	4	4	4	4	4	2	4	4	4	5	4	4
28	+ 20/50	29	4	4	4	4	4	2	4	4	4	4	4	4
41	- 20/50	39	4	4	4	4	4	2	4	4	4	5	4	4
35	+ 20/70	40	4	4	4	4	4	2	4	4	4	4	4	4
37	+ 20/80	56	2	2	3	2	2	2	3	3	3	4	4	4
12	+ 20/100	35	3	3	3	3	3	3	1	3	3	4	3	3
26	- 20/100	32	2	2	3	2	2	2	3	4	4	3	3	4
44	- 20/100	37	2	2	1	2	2	1	2	2	2	3	3	3
49	+ 20/50	51	4	4	2	4	4	2	4	4	4	4	4	4
1	= 20/200	30	2	2	2	2	2	2	3	2	2	2	2	2
7	= 20/200	33	3	3	4	3	3	1	1	4	4	4	4	3
13	= 20/200	51	3	3	3	3	3	2	5	3	3	4	3	3
14	= 20/200	55	3	3	2	3	3	1	2	3	3	3	3	3
34	= 20/200	45	3	3	4	4	4	4	4	4	4	4	4	4
45	= 20/200	65	4	4	4	4	4	2	3	4	4	5	4	4
6	+ 20/200	29	4	4	3	4	4	2	4	3	3	3	3	3
15	+ 20/200	28	4	5	3	4	4	2	3	4	3	4	4	3
48	+ 20/200	52	3	3	3	3	3	2	3	3	3	3	3	3
27	+ 20/200	62	4	4	4	4	4	2	4	4	4	4	4	4
33	+ 20/200	59	4	4	4	4	4	4	3	3	3	4	5	4
39	- 20/200	35	4	4	4	4	4	2	3	5	4	4	4	4
50	- 20/200	32	4	4	4	4	4	2	4	4	4	4	4	4
I-36	+ 15/200	32	3	3	3	3	3	2	1	3	3	3	3	3
II	= 14/200	34	3	2	2	2	2	2	2	2	2	2	2	2
24	+ 10/200	60	2	2	3	2	2	4	2	3	1	3	3	3
18	+ 10/200	28	3	3	4	3	5	1	3	3	4	3	3	3
31	+ 10/200	60	3	3	3	3	3	1	2	2	2	3	3	3
20	- 10/200	31	2	2	2	2	2	1	2	2	2	2	2	3
38	- 10/200	32	3	3	3	3	2	3	2	3	2	3	3	3
8	+ 9/200	59	3	2	3	2	2	2	3	3	3	3	3	3
46	= 5/200	30	3	4	3	3	3	1	2	4	3	4	4	4
11	= 5/200	38	1	1	1	1	2	1	1	1	1	1	1	1
21	= 5/200	55	1	1	1	1	1	1	1	1	1	1	1	1
40	= 5/200	24	2	2	3	2	2	3	2	3	3	3	3	3
2	+ 5/200	23	1	1	2	1	1	1	2	1	2	2	2	2
10	+ 4/200	31	1	1	1	1	1	1	1	1	1	3	2	2
43	+ 4/200	39	2	2	2	2	2	1	1	2	2	2	2	2
47	- 4/200	24	3	3	2	3	3	2	2	2	4	3	3	3
4	+ 3/200	43	1	1	1	1	1	1	1	1	1	1	1	1
16	+ 3/200	32	1	1	1	1	1	1	2	1	1	3	3	3
30	+ 3/200	39	2	3	2	2	2	2	2	3	3	3	3	3
5	= 2/200	61	3	3	2	3	3	1	2	2	2	2	2	2
25	= 1/200	29	1	1	1	1	1	1	1	1	1	1	1	1
3	+ 1/200	40	1	1	1	1	1	1	1	1	1	1	1	1
17	+ 1/200	26	1	1	1	1	1	1	2	1	3	2	2	2
32	+ 1/200	44	2	2	1	2	2	1	2	1	1	1	1	1
9	= HM 13"	53	2	2	1	2	2	1	1	1	1	2	3	3
22	+ HM 6"	57	1	1	1	1	1	1	1	1	1	1	1	1
23	+ HM 6"	55	1	1	1	1	1	1	1	1	1	1	1	1
42	= LP	41	1	1	1	1	1	1	1	1	1	1	2	2

HM-Hand Movements: LP-Light Perception; 5 - First Choice 4 - Second Choice

TABLE I

CASE	ACUITY DECREASING TEST EYE	AGE	MAGNIFIERS INCREASING -- POWER -- 1 1.5	2 1.4	12 1.4	3 1.4	4 1.3	10 1.8	11 2.0	13 1.5	15 1.5	16 2.3	17 2.0	18 2.5	LIGHT 19 2.0	7 2.8	9 2.8	8 3.0	14 3.0	6 4.5	5 6.0	20 4.0	20 5.0	DISEASES OF TEST EYE
29	+ 20/20	64	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	4	4	[4]	(5)	4		Chorio-Retinitis
19	= 20/40	36	4	4	4	4	4	2	4	4	4	(5)	4	4	4	4	4	4	4	4	4	[4]		Retinitis Pigmentosa
28	+ 20/50	29	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	[4]	4	(5)	4	4		Chorio-Retinitis, Central
41	- 20/50	39	4	4	4	4	4	2	4	4	4	(5)	[4]	4	4	4	4	4	4	4	4	4		" " "
35	+ 20/70	40	4	4	4	4	4	2	4	4	4	4	[4]	4	4	4	4	4	4	(5)	4	4		Corneal Opacity
37	+ 20/80	56	2	2	3	2	2	2	3	3	3	4	4	4	3	4	4	4	4	(5)	[4]	4	x_4	Macular Degeneration
12	+ 20/100	35	3	3	3	3	3	3	1	3	3	[4]	3	3	3	3	3	3	3	3	4	(5)		Chorio-Retinitis, Central
26	- 20/100	32	2	2	3	2	2	2	3	4	4	3	3	4	[4]	4	3	3	(5)	4	4	4		Glaucoma, Optic Atrophy (Vitreous Floaters)
44	- 20/100	37	2	2	1	2	2	1	2	2	2	3	3	3	2	3	4	3	(5)	3	[4]	3	x_4	Capsular Cataract (Early Frost)
49	+ 20/50	51	4	4	2	[4]	4	2	4	4	4	4	4	4	4	4	4	4	(5)	4	4	4	x_4	Chorio-Retinitis - Optic Atrophy
1	= 20/200	30	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	3	4	4	(5)	[4]	(5)	Macular Degeneration (Multiple Sclerosis)
7	= 20/200	33	3	3	4	3	3	1	1	4	4	4	[4]	3	(5)	4	4	4	4	4	4	4		Optic Atrophy - Psychogenic Overlay
13	= 20/200	51	3	3	3	3	3	2	(5)	3	3	4	3	3	3	4	4	[4]	3	3	4	2		Optic Atrophy - Tubular Visual Field
14	= 20/200	55	3	3	2	3	3	1	2	3	3	3	3	3	2	3	3	3	4	[4]	[4]	(5)	(5)	Optic Atrophy - (Retinal Degeneration)
34	= 20/200	45	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	(5)	4	[4]	4		Macular Degeneration -Central Scotoma
45	= 20/200	65	4	4	4	4	4	2	3	4	4	(5)	4	4	4	4	4	4	[4]	4	4	4	5	Cataract (Immature Nuclear) Macular Degeneration
6	+ 20/200	29	4	4	3	4	4	2	4	3	3	3	3	3	(5)	4	3	4	4	[4]	4	4		Optic Atrophy
15	+ 20/200	28	4	(5)	3	4	4	2	3	[4]	3	4	4	3	3	3	3	3	4	4	4	4	x_4	Chorio-Retinitis (Involving Macular)
48	+ 20/200	52	3	3	3	3	3	2	3	3	3	3	[3]	3	4	4	4	4	4	(5)	4	3	x_4	Corneal Opacities
27	+ 20/200	62	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	(5)	[4]	4	4	4		Corneal Scarring
33	+ 20/200	59	4	4	4	4	4	4	3	3	3	4	(5)	[4]	4	4	4	4	4	4	4	4	x_4	Chorio-Retinitis
39	- 20/200	35	4	4	4	4	4	2	3	(5)	4	4	4	4	3	4	4	[4]	4	4	4	4		Cataract (Complicated)
50	- 20/200	32	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	[4]	(5)	4	4	4	(5)	Optic Atrophy - Central Scotoma
I-36	+ 15/200	32	3	3	3	3	3	2	1	3	3	3	3	3	3	3	3	3	3	3	[4]	(5)		Chorio-Retinitis, Central
II	= 14/200	34	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	[4]	4	4	(5)	(5)	Cataract (History of Congenital type)
24	+ 10/200	60	2	2	3	2	2	[4]	2	3	1	3	3	3	2	3	3	3	(5)	3	4	3		Cataract (Complicated)-Retinitis Pigmentosa
18	+ 10/200	28	3	3	4	3	(5)	1	3	3	4	3	3	3	[4]	3	3	3	4	4	4	4		Optic Atrophy - Multiple Sclerosis
31	+ 10/200	60	3	3	3	3	3	1	2	2	2	3	3	3	3	4	4	(5)	[4]	4	4	3		Cataract - Diabetic Retinopathy
20	- 10/200	31	2	2	2	2	2	1	2	2	2	2	2	[3]	(3)	3	2	2	2	2	2	3		Chorio-Retinitis, Traumatic and Central
38	- 10/200	32	3	3	3	3	2	3	2	3	2	3	3	3	3	4	4	4	4	[4]	4	(5)		Corneal Opacity
8	+ 9/200	59	[3]	2	3	2	2	2	3	3	3	3	3	3	3	4	3	4	4	4	4	(5)		Cataract (Hyper-Mature) Thrombosis Cent. Ret. Vein.
46	= 5/200	30	3	[4]	3	3	3	1	2	4	3	4	4	4	3	3	4	4	3	(5)	4	4	(5)	Optic Atrophy
11	= 5/200	38	1	1	1	1	2	1	1	1	1	1	1	1	3	3	3	3	1	[4]	(5)	4	x_4	Optic Atrophy
21	= 5/200	55	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		Macular Degeneration
40	= 5/200	24	2	2	3	2	2	3	2	3	3	3	3	3	3	3	3	[3]	3	3	4	2	(5)	Optic Atrophy
2	+ 5/200	23	1	1	2	1	1	1	2	1	2	2	2	2	2	2	2	2	2	[3]	3	3		Optic Atrophy, Primary
10	+ 4/200	31	1	1	1	1	1	1	1	1	1	3	2	2	2	3	1	1	1	[3]	1	1	x_4	Chorio-Retinitis, Central
43	+ 4/200	39	2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	3	2	[3]	3	1	x_4	Corneal Opacities - Psychosis Unclassified
47	- 4/200	24	3	3	2	3	3	2	2	2	4	3	3	3	3	4	4	3	4	[4]	(5)	4	(5)	Optic Atrophy - Central Scotoma
4	+ 3/200	43	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	[3]	3	(4)	Optic Atrophy - Retinitis Pigmentosa
16	+ 3/200	32	1	1	1	1	1	1	2	1	1	3	3	3	2	2	1	1	1	2	[2]	2	3	Chorio-Retinitis, Central
30	+ 3/200	39	2	3	2	2	2	2	2	3	3	3	3	3	3	4	4	4	(5)	4	[4]	1		Cataract (Zonular)
5	= 2/200	61	3	3	2	3	3	1	2	2	2	2	2	2	(5)	3	3	3	2	3	[4]	4		Keratoconus
25	= 1/200	29	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2		Optic Atrophy
3	+ 1/200	40	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		Chorio-Retinitis
17	+ 1/200	26	1	1	1	1	1	1	2	1	3	2	[2]	2	3	3	3	3	3	3	3	1		Atrophy-Optic
32	+ 1/200	44	2	2	1	2	2	1	[2]	1	1	1	1	1	1	1	1	2	1	1	1	1		Cataract - Glaucoma
9	= HM 13"	53	2	2	1	2	2	1	1	1	1	2	3	3	3	3	1	2	2	3	3	[3]	(5)	Chorio-Retinitis, Central
22	+ HM 6"	57	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	x_4	Optic Atrophy-Retinitis Pigmentosa-Cataract
23	+ HM 6"	55	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		Optic Atrophy-Glaucoma
42	= LP	41	1	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	3	1	1	2	(4)	Optic Atrophy

HM-Hand Movements; LP-Light Perception; (5) - First Choice [4] - Second Choice

X_4 - Original First Choice Stands

LIGHT									DISEASES OF TEST EYE
19	7	9	8	14	6	5	20	20	
2.0	2.8	2.8	3.0	3.0	4.5	6.0	4.0	5.0	
4	4	4	4	4	$\boxed{4}$	5	4		Chorio-Retinitis
4	4	4	4	4	4	4	$\boxed{4}$		Retinitis Pigmentosa
4	4	4	$\boxed{4}$	4	5	4	4		Chorio-Retinitis, Central
4	4	4	4	4	4	4	4		" " "
4	4	4	4	4	5	4	4		Corneal Opacity
3	4	4	4	4	5	$\boxed{4}$	4	x_4	Macular Degeneration
3	3	3	3	3	3	4	5		Chorio-Retinitis, Central
$\boxed{4}$	4	3	3	5	4	4	4		Glaucoma, Optic Atrophy (Vitreous Floaters)
2	3	4	3	5	3	$\boxed{4}$	3	x_4	Capsular Cataract (Early Frost)
4	4	4	4	5	4	4	4	x_4	Chorio-Retinitis - Optic Atrophy
2	2	2	3	4	4	5	$\boxed{4}$	5	Macular Degeneration (Multiple Sclerosis)
5	4	4	4	4	4	4	4		Optic Atrophy - Psychogenic Overlay
3	4	4	$\boxed{4}$	3	3	4	2		Optic Atrophy - Tubular Visual Field
2	3	3	3	4	$\boxed{4}$	$\boxed{4}$	5	5	Optic Atrophy - (Retinal Degeneration)
4	4	4	4	5	4	$\boxed{4}$	4		Macular Degeneration -Central Scotoma
4	4	4	4	$\boxed{4}$	4	4	4	5	Cataract(Immature Nuclear) Macular Degeneration
5	4	3	4	4	$\boxed{4}$	4	4		Optic Atrophy
3	3	3	3	4	4	4	4	x_4	Chorio-Retinitis (Involving Macular)
4	4	4	4	4	5	4	3	x_4	Corneal Opacities
4	4	4	5	$\boxed{4}$	4	4	4		Corneal Scarring
4	4	4	4	4	4	4	4	x_4	Chorio-Retinitis
3	4	4	$\boxed{4}$	4	4	4	4		Cataract (Complicated)
4	4	4	$\boxed{4}$	5	4	4	4	5	Optic Atrophy - Central Scotoma
3	3	3	3	3	3	$\boxed{4}$	5		Chorio-Retinitis, Central
2	3	3	3	$\boxed{4}$	4	4	5	5	Cataract (History of Congenital type)
2	3	3	3	5	3	4	3		Cataract (Complicated)-Retinitis Pigmentosa
$\boxed{4}$	3	3	3	4	4	4	4		Optic Atrophy - Multiple Sclerosis
3	4	4	5	$\boxed{4}$	4	4	3		Cataract - Diabetic Retinopathy
3	3	2	2	2	2	2	3		Chorio-Retinitis, Traumatic and Central
3	4	4	4	4	$\boxed{4}$	4	5		Corneal Opacity
3	4	3	4	4	4	4	5		Cataract(Hyper-Mature)Thrombosis Cent. Ret.Vein.
3	3	4	4	3	5	4	4	5	Optic Atrophy
3	3	3	3	1	$\boxed{4}$	5	4	x_4	Optic Atrophy
1	1	1	1	1	1	1	1		Macular Degeneration
3	3	3	$\boxed{3}$	3	3	4	2	5	Optic Atrophy
2	2	2	2	2	$\boxed{3}$	3	3		Optic Atrophy, Primary
2	3	1	1	1	$\boxed{3}$	1	1	x_4	Chorio-Retinitis, Central
2	2	2	3	2	$\boxed{3}$	3	1	x_4	Corneal Opacities - Psychosis Unclassified
3	4	4	3	4	$\boxed{4}$	5	4	5	Optic Atrophy - Central Scotoma
4	1	1	1	1	1	$\boxed{3}$	3	4	Optic Atrophy - Retinitis Pigmentosa
2	2	1	1	1	2	$\boxed{2}$	2	3	Chorio-Retinitis, Central
3	4	4	4	5	4	$\boxed{4}$	1		Cataract (Zonular)
5	3	3	3	2	3	$\boxed{4}$	4		Keratoconus
1	1	1	1	1	1	1	2		Optic Atrophy
1	1	1	1	1	1	1	1		Chorio-Retinitis
3	3	3	3	3	3	3	1		Atrophy-Optic
1	1	1	1	2	1	1	1		Cataract - Glaucoma
3	3	1	2	2	3	3	$\boxed{3}$	5	Chorio-Retinitis, Central
1	1	1	1	1	1	1	1	x_4	Optic Atrophy-Retinitis Pigmentosa-Cataract
1	1	1	1	1	1	1	1		Optic Atrophy-Glaucoma
2	1	1	1	3	1	1	2	4	Optic Atrophy

X_4 - Original First Choice Stands

TABLE II SUMMARIES OF RATINGS

MAGNIFIERS	20	20	14	5	6	8	19	16	17	13	11	18	2	4	7	9	1	3	12	15	10
MAGNIFICATION	5.0	4.0	3.0	6.0	4.5	3.0	2.0	2.3	2.0	1.5	2.0	2.5	1.4	1.3	2.8	2.8	1.5	1.4	1.4	1.5	1.8
TOTAL NUMBER OF 5's	9	6	7	4	5	2	3	3	1	1	1	0	1	1	0	0	0	0	0	0	0
" " " 4's	11	23	22	32	24	20	15	15	15	14	10	15	13	14	23	22	13	14	14	15	3
" " " 3's	1	8	7	5	12	16	17	16	18	14	10	20	13	10	16	14	15	12	13	14	3
" " " 2's	0	5	6	2	2	3	10	8	9	8	16	8	12	15	4	4	11	13	10	9	22
" " " 1's	1	9	9	8	7	10	6	9	8	14	14	8	12	11	8	11	12	12	14	13	23
TOTAL NUMBER OF SUBJECTS	22	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
TOTAL FIRST CHOICES 5 5	12	6	7	4	5	2	3	3	1	1	1	0	1	1	0	0	0	0	0	0	0
TOTAL SECOND CHOICES 4	3	3	4	8	9	5	2	1	5	1	1	2	1	0	0	0	1	1	0	0	1
TOTAL REJECTIONS (1's & 2's)	1	14	15	10	9	13	16	17	17	22	30	16	24	26	12	15	23	25	24	22	45

MEANINGS OF SYMBOLS USED IN TABLE I --

5 - First Choice Magnifiers & Satisfactory Reading With The Device.

5 - Used Only With Franklin Institute Device Which Was Obtained After Tests Were Nearly Completed. This Symbol Means That The F.I. Projector Would Have Been First Choice For Those Subjects Who Used It and Liked It Best. But It Was Not Officially In the Study.

4 3 - First Choice Magnifiers But Not Satisfactory As A Reading Device.

4 3 - Second Choice Magnifiers Of Highest And Lower Order Of Satisfaction

TABLE III
MAGNIFIERS' PERFORMANCE

NO.	MAG. & CORCTN	FIELD	GENERAL DESCRIPTION	5	4	3	2	1
			CASES →	23, 3, 17, 32, 9, 22, 23, 42				
			RATINGS →	1/200 & less				
20	4.0X S	4 3/4" X 6 1/2"	Perkins Projector - Ground Glass Screen	0	0	1	2	5
14	3.0X C&S	1 3/4" Dia.	Rochester Univ. Spot Magnifier Two 7-Watt Incandescent	0	0	2	2	4
5	5.0 C&S	3/4" Dia	Small Handy Triplet Vest Pocket Size	0	0	2	0	6
6	4.5 C&S	1 1/4" Dia	Horse Shoe Base, Doublet	0	0	2	0	6
8	3.0 C&S	1 3/4" Dia	Hand-held Doublet In Ring	0	0	1	1	6
19	2.0 C&S	5" Dia.	E. D. M. PLASTIC - Much Light	0	0	2	2	5
16	2.3 C&S	4 1/2" Dia	Plastic Aspheric Dartmouth Std. One 4-Watt Fluorescent Light	0	0	0	2	6
17	2.0	5" Dia	Glass - Dartmouth Reading Stand	0	0	1	2	5
13	1.5 C&S	1" x 2 1/2"	STOCKER & YALE DEVICE Rectangular Lens, Two 4-Watt Fluorescent Lights	0	0	0	0	8
11	2.0 C&S	6" Dia	Rochester Univ. 4 Elements	0	0	0	2	6
18	2.5	5" Dia	Glass - Dartmouth Reading Stand	0	0	1	2	6
2	1.4 C&S	2" x 4"	Hand-Held Rectangular Bi-Convex	0	0	0	2	6
4	1.3 C&S	5" Dia	" " Round "	0	0	0	2	6
7	2.8 C&S	2" Dia	Horse Shoe Base, Doublet Lens held with Ball and Socket Joint	0	0	2	0	6
9	2.8 C&S	2" Dia	Flat Iron Base - 8" Friction Arm Lens held with Ball & Socket Joint	0	0	1	0	7
1	1.5 C&S	3 1/2" Dia.	Hand-Held Round Bi-Convex	0	0	0	2	6
3	1.4 C&S	4 1/2" Dia	" " " "	0	0	0	2	6
12	1.4 C&S	2" x 4"	Base #9, Lens #2	0	0	0	0	8
15	1.5 C&S	5" Dia	Stanley #701 One 4-Watt Fluorescent	0	0	1	0	7
10	1.8 C&S	1" Dia	Telescopic Spectacles	0	0	0	0	8

TABLE III
MAGNIFIERS' PERFORMANCE

NO.	MAG. & CORC'TN	FIELD	GENERAL DESCRIPTION	23, 3, 17, 32, 9, 22, 23, 42 — 1/200 & less (8)					46, 11, 21, 40, 2, 47, 10, 43, 16, 30, 5, 4 — 2-5/200 (12)					I, II, 18, 31, 20, 38, 8, 24 — 6-15/200 (8)					45, 1, 7, 13, 14, 34, 6, 15, 48, 33, 39, 27, 50 — 16-20/200 (13)					29, 19, 28, 41, 35, 37, 12, 26, 44, 49 — Above 20/200 (10)					TOTAL 51 CASES — COMPOSITE				
			RATINGS →	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
20	4.0X S	4 3/4" X 6 1/2"	Perkins Projector - Ground Glass Screen	0	0	1	2	5	0	4	2	2	4	4	1	3	0	0	1	10	1	1	0	1	8	1	0	0	6	23	8	5	9
14	3.0X C&S	13/4" Dia.	Rochester Univ. Spot Magnifier Two 7-Watt Incandescent	0	0	2	2	4	1	1	2	3	5	1	5	1	1	0	2	10	1	0	0	3	6	1	0	0	7	22	1	6	9
5	5.0 C&S	3/4" Dia	Small Handy Triplet Vest Pocket Size	0	0	2	0	6	2	4	3	1	2	0	7	0	1	0	1	12	0	0	0	1	9	0	0	0	4	32	5	2	8
6	4.5 C&S	1 1/4" Dia	Horse Shoe Base, Doublet	0	0	2	0	6	1	3	5	1	2	0	5	2	1	0	1	11	1	0	0	3	5	2	0	0	5	24	12	2	8
8	3.0 C&S	1 3/4" Dia	Hand-held Doublet In Ring	0	0	1	1	6	0	2	5	1	4	1	2	4	1	0	1	9	3	0	0	0	7	3	0	0	2	20	16	3	10
19	2.0 C&S	5" Dia.	E. D. M. PLASTIC - Much Light	0	0	2	2	5	1	1	5	3	1	0	1	5	2	0	2	6	3	2	0	0	7	2	1	0	3	15	17	10	6
16	2.3 C&S	4 1/2" Dia	Plastic Aspheric Dartmouth Std. One 4-Watt Fluorescent Light	0	0	0	2	6	0	1	5	3	3	0	0	6	2	0	1	8	3	1	0	2	6	2	0	0	3	15	16	8	9
17	2.0	5" Dia	Glass - Dartmouth Reading Stand	0	0	1	2	5	0	1	4	4	3	0	0	6	2	0	1	7	4	1	0	0	7	3	0	0	1	15	18	9	8
13	1.5 C&S	1" x 2 1/2"	STOCKER & YALE DEVICE Rectangular Lens, Two 4-Watt Fluorescent Lights	0	0	0	0	8	0	1	2	3	6	0	0	5	3	0	1	6	5	1	0	1	7	2	0	0	1	14	14	8	14
11	2.0 C&S	6" Dia	Rochester Univ. 4 Elements	0	0	0	2	6	0	0	0	7	5	0	0	2	5	1	1	4	6	1	1	0	6	2	1	1	1	10	10	16	14
18	2.5	5" Dia	Glass - Dartmouth Reading Stand	0	0	1	2	6	0	1	4	4	3	0	0	7	1	0	0	6	6	0	0	0	8	2	0	0	0	15	20	8	8
2	1.4 C&S	2"×4"	Hand-Held Rectangular Bi-Convex	0	0	0	2	6	0	1	3	2	6	0	0	4	4	0	1	6	5	1	0	0	6	1	3	0	1	13	13	12	12
4	1.3 C&S	5" Dia	" " Round "	0	0	0	2	6	0	0	3	4	5	1	0	2	5	0	0	8	4	1	0	0	6	1	3	0	1	14	10	15	11
7	2.8 C&S	2" Dia	Horse Shoe Base, Doublet Lens held with Ball and Socket Joint	0	0	2	0	6	0	2	5	3	2	0	3	5	0	0	0	10	2	1	0	0	8	2	0	0	0	23	16	4	8
9	2.8 C&S	2" Dia	Flat Iron Base - 8" Friction Arm Lens held with Ball & Socket Joint	0	0	1	0	7	0	3	3	1	4	0	2	5	1	0	0	9	3	2	0	0	8	2	0	0	0	22	14	4	11
1	1.5 C&S	3 1/2" Dia.	Hand-Held Round Bi-Convex	0	0	0	2	6	0	0	3	3	6	0	0	6	2	0	0	7	5	1	0	0	6	1	3	0	0	13	15	11	12
3	1.4 C&S	4 1/2" Dia	" " " "	0	0	0	2	6	0	0	3	3	6	0	0	4	4	0	0	8	4	1	0	0	6	1	3	0	0	14	12	13	12
12	1.4 C&S	2"×4"	Base #9, Lens #2	0	0	0	0	8	0	0	2	5	5	0	1	5	2	0	0	7	4	2	0	0	5	3	1	1	0	14	13	10	14
15	1.5 C&S	5" Dia	Stanley #701 One 4-Watt Fluorescent	0	0	1	0	7	0	1	3	3	5	0	1	2	4	1	0	6	6	1	0	0	7	2	1	0	0	15	14	9	13
10	1.8 C&S	1" Dia	Telescopic Spectacles	0	0	0	0	8	0	0	1	2	9	0	1	1	3	3	0	2	0	9	2	0	0	1	8	1	0	3	3	22	23

46, 11, 21, 40, 2, 47, 10, 43, 16, 30, 5, 4. 2-5/200					12	I, II, 18, 31, 20, 38, 8, 24 6-15/200					8	45, 1, 7, 13, 14, 34, 6, 15, 48, 33, 39, 27, 50 16-20/200					13	29, 19, 28, 41, 35, 37, 12, 26, 44, 49 Above 20/200					10	TOTAL 51 CASES COMPOSITE				
5	4	3	2	1		5	4	3	2	1		5	4	3	2	1		5	4	3	2	1		5	4	3	2	1
0	4	2	2	4		4	1	3	0	0		1	10	1	1	0		1	8	1	0	0		6	23	8	5	9
1	1	2	3	5		1	5	1	1	0		2	10	1	0	0		3	6	1	0	0		7	22	7	6	9
2	4	3	1	2		0	7	0	1	0		1	12	0	0	0		1	9	0	0	0		4	32	5	2	8
1	3	5	1	2		0	5	2	1	0		1	11	1	0	0		3	5	2	0	0		5	24	12	2	8
0	2	5	1	4		1	2	4	1	0		1	9	3	0	0		0	7	3	0	0		2	20	16	3	10
1	1	5	3	1		0	1	5	2	0		2	6	3	2	0		0	7	2	1	0		3	15	17	10	6
0	1	5	3	3		0	0	6	2	0		1	8	3	1	0		2	6	2	0	0		3	15	16	8	9
0	1	4	4	3		0	0	6	2	0		1	7	4	1	0		0	7	3	0	0		1	15	18	9	8
0	1	2	3	6		0	0	5	3	0		1	6	5	1	0		1	7	2	0	0		1	14	14	8	14
0	0	0	7	5		0	0	2	5	1		1	4	6	1	1		0	6	2	1	1		1	10	10	16	14
0	1	4	4	3		0	0	7	1	0		0	6	6	0	0		0	8	2	0	0		0	15	20	8	8
1	1	3	2	6		0	0	4	4	0		1	6	5	1	0		0	6	1	3	0		1	13	13	12	12
1	0	3	4	5		1	0	2	5	0		0	8	4	1	0		0	6	1	3	0		1	14	10	15	11
1	2	5	3	2		0	3	5	0	0		0	10	2	1	0		0	8	2	0	0		0	23	16	4	8
0	3	3	1	4		0	2	5	1	0		0	9	3	2	0		0	8	2	0	0		0	22	14	4	11
0	0	3	3	6		0	0	6	2	0		0	7	5	1	0		0	6	1	3	0		0	13	15	11	12
0	0	3	3	6		0	0	4	4	0		0	8	4	1	0		0	6	1	3	0		0	14	12	13	12
0	0	2	5	5		0	1	5	2	0		0	7	4	2	0		0	5	3	1	1		0	14	13	10	14
0	1	3	3	5		0	1	2	4	1		0	6	6	1	0		0	7	2	1	0		0	15	14	9	13
0	0	1	2	9		0	1	1	3	3		0	2	0	9	2		0	0	1	8	1		0	3	3	22	23

TABLE IV

ANALYSIS OF DESIGN ELEMENTS OF EXISTING MAGNIFIERS

Magnifiers bers	Power	Lens Systems No. of Material Elements Size F.L.	Lens Holders	Mountings	Lighting
5	6.0	Glass Triplet; 3/4"dia.; 1-5/8" Field Corrected For Chromatic and Spherical Aberration	Near circular Chrome plated Folding Case.	None	None
5	4.5	Glass Doublet 1.4"dia.; 2.2" Field Corrected For Chromatic and Spherical Aberration	Copper Cylinder Flat Black Finish Threaded For Focusing Up and Down 1-3/4"dia. 1-5/8"Long	Horse Shoe BASE	None
	3.0	Glass Doublet 1-3/4"dia.;3.15" ½" space between lenses Field Corrected C.&S.A.	2-Piece Molded Tenite Ring.Black	None	None
	3.0	Glass Doublet 1.7"dia.; 3.15" Field Corrected for C.&S.A.	Machined-Aluminum Cast Cylinder 2-1/4"dia.; 1-1/2"long Threaded for Focusing Up and Down	Roll Film Camera Type Case	Two, 7-Watt Incandescent Filament Lamps Clear Glass 20 Foot Candles
	2.3	Plastic Aspheric 5"dia.; 6" Field Corrected for C.&S.A.	Cast-Aluminum Carries Light and Slides Up and Down. Square hollow Aluminum Shaft which is Secured in Heart Shaped Base. Book stand 11"x12" attached to shaft.	Cast-Aluminum	One, 4-Watt Fluorescent Day Light bulb, 40 foot Candles
	2.0	Plastic Aspheric 5"dia.; 10" Field Corrected for C.&S.A.	Glass cell secured to white semi-transparent shade. Tilts and slides up and down to be fastened in base	Cast-Aluminum Horse Shoe Type Base 16" wide holds electrical units.	One, 32-Watt Circular Fluorescent tube 200-250 ft. Candles
	1.4	Glass 2" x 4" Rectangular Field Corrected for C.&S.A.	ELIMINATED	None	None
	2.0	Glass Cemented 5"dia.; 5" Field Corrected Some	COVERED UNDER MAGNIFIER NUMBER 16		

46, 11, 21, 40, 2, 47, 10, 43, 16, 30, 5, 4. 2-5/200					12	I, II, 18, 31, 20, 38, 8, 24 6-15/200					8	45, 1, 7, 13, 14, 34, 6, 15, 48, 33, 39, 27, 50 16-20/200					13	29, 19, 28, 41, 35, 37, 12, 26, 44, 49 Above 20/200					10	TOTAL 51 CASES COMPOSITE				
5	4	3	2	1		5	4	3	2	1		5	4	3	2	1		5	4	3	2	1		5	4	3	2	1
0	4	2	2	4		4	1	3	0	0		1	10	1	1	0		1	8	1	0	0		6	23	8	5	9
1	1	2	3	5		1	5	1	1	0		2	10	1	0	0		3	6	1	0	0		7	22	7	6	9
2	4	3	1	2		0	7	0	1	0		1	12	0	0	0		1	9	0	0	0		4	32	5	2	8
1	3	5	1	2		0	5	2	1	0		1	11	1	0	0		3	5	2	0	0		5	24	12	2	8
0	2	5	1	4		1	2	4	1	0		1	9	3	0	0		0	7	3	0	0		2	20	16	3	10
1	1	5	3	1		0	1	5	2	0		2	6	3	2	0		0	7	2	1	0		3	15	17	10	6
0	1	5	3	3		0	0	6	2	0		1	8	3	1	0		2	6	2	0	0		3	15	16	8	9
0	1	4	4	3		0	0	6	2	0		1	7	4	1	0		0	7	3	0	0		1	15	18	9	8
0	1	2	3	6		0	0	5	3	0		1	6	5	1	0		1	7	2	0	0		1	14	14	8	14
0	0	0	7	5		0	0	2	5	1		1	4	6	1	1		0	6	2	1	1		1	10	10	16	14
0	1	4	4	3		0	0	7	1	0		0	6	6	0	0		0	8	2	0	0		0	15	20	8	8
0	1	3	2	6		0	0	4	4	0		1	6	5	1	0		0	6	1	3	0		1	13	13	12	12
0	0	3	4	5		1	0	2	5	0		0	8	4	1	0		0	6	1	3	0		1	14	10	15	11
0	2	5	3	2		0	3	5	0	0		0	10	2	1	0		0	8	2	0	0		0	23	16	4	8
0	3	3	1	4		0	2	5	1	0		0	9	3	2	0		0	8	2	0	0		0	22	14	4	11
0	0	3	3	6		0	0	6	2	0		0	7	5	1	0		0	6	1	3	0		0	13	15	11	12
0	0	3	3	6		0	0	4	4	0		0	8	4	1	0		0	6	1	3	0		0	14	12	13	12
0	0	2	5	5		0	1	5	2	0		0	7	4	2	0		0	5	3	1	1		0	14	13	10	14
0	1	3	3	5		0	1	2	4	1		0	6	6	1	0		0	7	2	1	0		0	15	14	9	13
0	0	1	2	9		0	1	1	3	3		0	2	0	9	2		0	0	1	8	1		0	3	3	22	23

TABLE IV

ANALYSIS OF DESIGN ELEMENTS OF EXISTING MAGNIFIERS

Magnifiers Numbers	Power	Lens Systems No. of Material Elements Size F.L.	Lens Holders	Mountings	Lighting	OVERALL SIZES	PORTABILITY	REMARKS
5	6.0	Glass Triplet; 3/4"dia.; 1-5/8" Field Corrected For Chromatic and Spherical Aberration	Near circular Chrome plated Folding Case.	None	None	7/8"x5/8"x1-3/8"	Fits into Vest or Watch pocket.	Field Too Small for Reading long Less Magnification suitable
6	4.5	Glass Doublet 1.4"dia.; 2.2" Field Corrected For Chromatic and Spherical Aberration	Copper Cylinder Flat Black Finish Threaded For Focusing Up and Down 1-3/4"dia. 1-5/8"Long	Horse Shoe BASE	None	2¼"x2½" Base 2½"to3½" High	Fits into Jacket or Coat Pocket	Field Too Small For Practical Use in Reading though without distortions. Less Magnification seems permissible
8	3.0	Glass Doublet 1-3/4"dia.;3.15" ½" space between lenses Field Corrected C.&S.A.	2-Piece Molded Tenite Ring.Black	None	None	Effectively a Cylinder 2¼"dia. 1-3/8" Long.	Fits into Jacket or Coat Pocket	Could be more compact without less of Best features. Magnification near proper level Field very good. Should show reasonable Cost.
4	3.0	Glass Doublet 1.7"dia.; 3.15" Field Corrected for C.&S.A.	Machined-Aluminum Cast Cylinder 2-1/4"dia.; 1-1/2"long Threaded for Focusing Up and Down	Roll Film Camera Type Case	Two, 7-Watt Incandescent Filament Lamps Clear Glass 20 Foot Candles	Rectangular Box 3-3/4"x5"x3"	Fits in side Waistcoat Pocket or Camera Case.	Lighting about right Magnification about right Field is good but evades peripheral vision Depth between lens Elements Possibly too great.
5	2.3	Plastic Aspheric 5"dia.; 6" Field Corrected for C.&S.A.	Cast-Alumimum Carries Light and Slides Up and Down. Square hollow Aluminum Shaft which is Secured in Heart Shaped Base. Book stand 11"x12" attached to shaft.	Cast-Aluminum	One, 4-Watt Fluorescent Day Light bulb, 40 foot Candles	Fits on Table with Top 15"x18" It stands 11½"high	Box 15"x18"x12"	Not enough Magnification Awkward to Manipulate Lighting about right Field good Except for color which annoys.
9	2.0	Plastic Aspheric 5"dia.; 10" Field Corrected for C.&S.A.	Glass cell secured to white semi-transparent shade. Tilts and slides up and down to be fastened in base	Cast-Aluminum Horse Shoe Type Base 16" wide holds electrical units.	One, 32-Watt Circular Fluorescent tube 200-250 ft. Candles	Fits on Table with Top 16"x16" Stands 15"high	Box 16"x16"x16"	Not enough Magnification and Too much light for the average need. Easy to Manipulate Field Very Good but Colors persist with Long use.
2	1.4	Glass 2" x 4" Rectangular Field Corrected for C.&S.A.	ELIMINATED	None	None	COVERED	COVERED	Efficient Shape For Field Needs Higher Magnification.
7	2.0	Glass Cemented 5"dia.; 5" Field Corrected Some	COVERED UNDER MAGNIFIER NUMBER 16					Colors Show besides letters Distortion at edges.

OVERALL SIZES	PORTABILITY	REMARKS
7/8"x5/8"x1-3/8"	Fits into Vest or Watch pocket.	Field Too Small for Reading long Less Magnification suitable
$2\frac{1}{4}$"x$2\frac{1}{2}$" Base $2\frac{1}{2}$"to$3\frac{1}{2}$" High	Fits into Jacket or Coat Pocket	Field Too Small For Practical Use in Reading though without distortions. Less Magnification seems permissible
Effectively a Cylinder $2\frac{1}{4}$"dia. 1-3/8" Long.	Fits into Jacket or Coat Pocket	Could be more compact without less of Best features. Magnification near proper level Field very good. Should show reasonable Cost.
Rectangular Box 3-3/4"x5"x3"	Fits in side Waistcoat Pocket or Camera Case.	Lighting about right Magnification about right Field is good but evades peripheral vision Depth between lens Elements Possibly too great.
Fits on Table with Top 15"x18" It stands $11\frac{1}{2}$"high	Box 15"x18"x12"	Not enough Magnification Awkward to Manipulate Lighting about right Field good Except for color which annoys.
Fits on Table with Top 16"x16" Stands 15"high	Box 16"x16"x16"	Not enough Magnification and Too much light for the average need. Easy to Manipulate Field Very Good but Colors persist with Long use.
COVERED	COVERED	Efficient Shape For Field Needs Higher Magnification.
		Colors Show besides letters Distortion at edges.

[illegible]

[illegible]

[illegible] Table [illegible]

[illegible]

Table 13 was constructed [illegible] of determining the overall [illegible] magnifiers [illegible] in Table [illegible]

[illegible] magnifiers [illegible] may be [illegible] could [illegible]

A recent book, [illegible]

[illegible] interrupted by the [illegible] of magnifiers Nos. 8 and 9. [illegible] their positions from the [illegible] of table [illegible] more would [illegible] loss after Magnifier No. 6. [illegible] the [illegible] scale. [illegible] Nos. 8 and 9 shows [illegible] from the [illegible] of the [illegible]

[illegible]

[illegible] than [illegible] of [illegible]

for result [illegible] used to [illegible]

Regarding [illegible] No. 7 and [illegible]

their [illegible]

optical [illegible] of No. 8 is

identical with that of No. [illegible]

neither No. 7 nor No. [illegible] magnification [illegible]

ratings of 5 or [illegible] while No. [illegible]

received [illegible] ratings of [illegible]

were able [illegible] with [illegible].

Therefore No. [illegible] and No. [illegible] from the list of

remaining [illegible]

whatever they have [illegible] No. [illegible] higher

magnification in addition.

No. [illegible] may be eliminated [illegible] 5's of

4's, also [illegible] rejections, because the stand and [illegible] were

identical with those of No. 16 [illegible]. The [illegible]

highest ratings of 4 and 5 were [illegible]

of Nos. 16 and 17 since both received ratings of 5 while No. 18 [illegible]

The lens is the only feature of difference among the three devices.

A solution of problem number one was achieved through a process of combination rather than elimination. There were a few duplications of various features which were deliberately added as a means of roughly checking on the answers or reactions indicated in the tests. A major

[illegible] wrong if it is used as [illegible] type with the lamp and lens system, mounted [illegible]. Nevertheless, if a subject [illegible] as small as eight point type [illegible] and better from type with a 2.0 power magnifier [illegible] reliable - could be indicated, since the subjects had no previous experience or familiarization with the devices.

As a result of the considerations given in the portion of outline 2 previously, direct-view magnifiers [illegible] 9, 10, 11, and 12 seemed to encompass all of the desirable design elements [illegible] by all of the direct-view magnifiers used in the study.

Table IV was made to summarize the [illegible] characteristics of these six magnifiers broken down into [illegible] and [illegible] single page.

It may be safely stated that the single direct-view magnifier or projection magnifier of the type [illegible] full page [illegible] satisfactory as a reading device for all subjects with [illegible] equal acuity of 20/200 or less. The high response to our call for subjects seems to indicate the very real need for a magnifier of a better type.

If a better direct-view lens type magnifier is to be developed it must combine the compatible features among the desirable design elements found in those six remaining magnifiers. Such a new magnifier would be expected to supplement the projection type rather than displace it in the field of visual aids for the partially sighted. Each has advantages and disadvantages not possessed by the other, yet both have many good and a few bad common characteristics.

[illegible]

[illegible] served by [illegible] magnifiers [illegible] It may likewise be [illegible] and projector [illegible] type [illegible] some to help the [illegible] read [illegible]

The partially-sighted [illegible] along in this study, but [illegible] better observed by including [illegible] ions are not [illegible] ters.

All experiments [illegible] devices were not [illegible] over [illegible]

The present [illegible] in lighting [illegible] between the letters or words are [illegible]

Both types of magnifiers [illegible] by providing a means for the [illegible] the writing.

The visual acuity [illegible] the subjects within the 2/200 to 20/200 range inclusive. However, [illegible] of them chose magnifiers with fields suitable only for monocular vision. The other two thirds depend on the better eye to read, and therefore should not find monocular vision in a reading device unpleasant. There [illegible]

[illegible]

[illegible]

Of the forty persons [illegible] nine were for the projection type [illegible] and [illegible] for direct, [illegible] that had magnification above 4.0 power. [illegible] all first choices were for lenses having magnification of 3.0 power or less. Only three first choices were for lenses having magnification less than 2.0 power.

The median in order of power of magnification for direct view magnifiers seems to be near 3.0 power. [illegible] first choices were above, nine at 3.0 power and eleven below. This feature, combined with the wider and clearer visual field compatible, [illegible] set it up for the design of the optical system. The reason [illegible] to close to the [illegible] found in Nos. 8 and 14. In reading [illegible] holder for the lenses could afford a handy field magnifier.

Fifteen first choices were for devices that were self-illuminating; this does not include the projection devices, and neither does this include the many more who would have chosen a self-lighted device with a decreased intensity portable lens system for field use. The question must be made whether to include self-illumination or not to include it. The present evidence seems decidedly in favor of including self-illumination.

The remaining questions on lighting are how much and what type. At least a hint, if not a yardstick, may be gained from the discussions with subjects about lighting. Many subjects who could read perfectly well with No. 19, and others who read perfectly with none, liked No. 19 best because of its great brightness. There were other subjects who remarked that No. 19 was too bright and hurt their eyes.

[illegible]

[illegible] (Snellen) [illegible]

[illegible]

[illegible]

[illegible] acuities [illegible] 20/200 and all of the [illegible] to equal or better than 1/2 [illegible] [illegible] of 20/40, 5/200 and 5/200 [illegible] [illegible] at least one of [illegible] better than [illegible] 5/200 or 10/200.

[illegible] acuity of either [illegible] 5/200, [illegible] 5/200 or above.

D. If [illegible] the projection type would be [illegible] [illegible] of magnifier because:

1. The projection type permits free head movement.

2. The projection type with vertical or sweeping [illegible] screen permits the [illegible] to remain erect.

3. The projection type permits binocular vision.

(Nevertheless, there is a tendency for one-third of the subjects to choose magnifiers which provide fields suitable only for monocular vision, and the balance of the experimental group tends to depend on the better eye. In consequence, about 30% may be expected to accept a monocular direct-view magnifier if its other features

[illegible]

[illegible]

1. [illegible]

a. [illegible]

b. [illegible]

c. [illegible]

d. [illegible]

e. [illegible]

f. [illegible]

g. [illegible]

h. [illegible]

i. [illegible]

j. Suggestions [illegible]

1. [illegible]

2. [illegible] level of [illegible], with provision [illegible] source of power for [illegible] weight, and [illegible]

3. Interchanger [illegible] area should be [illegible] suitable [illegible]

4. Natural [illegible] open or [illegible]

5. Interchange [illegible] available.

6. Width of [illegible] of [illegible] newspaper

[illegible]

[illegible] lens [illegible] magnification, [illegible] chromatic [illegible] may be permitted. [illegible] lens with [illegible] too [illegible] [illegible] by engravers, [illegible], or [illegible] [illegible] as possible [illegible].

[illegible] Considerations [illegible] permitting a bigger product [illegible] of [illegible] given [illegible] together than is possible [illegible].

[illegible] Optical elements [illegible] or serious scratching, is [illegible]

a. hardness of [illegible]

b. a hard [illegible] [illegible]

c. high [illegible] [illegible].

10. The lens [illegible] should permit [illegible] [illegible], maintenance of adjustment, [illegible] into the body of the magnifier [illegible] [illegible] preferably the lenses and mount should be removable [illegible] pocket when extreme portability is required.

11. The device should operate [illegible] in all positions.

12. A notch for the finger tip is desirable to return the magnifier to the proper position after reading a long line.

13. A portable support for book, magazine, or newspaper permitting operation of the magnifier with the reading material inclined at 45° and preferably up to 60° from the horizontal should be provided. A hinged panel with folding legs, an easel, or an adaptation of a

[illegible]

D. Ideally, [illegible] should be positioned to free the user's hands. A rod or curved leg surface [illegible] clamp, and the use of the power [illegible] as a supporting [illegible] should be investigated. The side of the [illegible] material might have a [illegible] finish on paper and yet not tend to erase or transmit dirt and [illegible] smudges.

E. Costs of tooling individual [illegible] should be kept low, particularly if the devices are available to non-veteran users of moderate means.

K. The University of Rochester [illegible], No. 4, comes close to meeting the above specifications and rates highest in the several candidates.

L. Further development of the University of Rochester Lens Magnifier and design of a support seem terminally feasible.

APPENDIX I

GLOSSARY OF EYE DISEASES

Vision is due to the stimulation of the hind portion of the brain. When rays of light strike an object in space, they are reflected onto the retina of the eye. The rays impinge upon the front of the eye and then are transmitted through the eye to the back of the eye where they stimulate the macula lutea of the retina. Thence these rays set up impulses which are conducted through nerve fibers to the brain. In the brain, these impulses are perceived as light.

Faulty vision will result when any one of the following factors or combination of factors exists:

a. Interference with transmission of light rays from front of eye to the back of the eye.

b. Interference with conduction of light impulses from the back of the eye to the brain.

c. Interference with the perception of light in the brain.

In this survey the subjects were selected from those whose disabilities are encompassed in a and b of above. Functional and organic diseases of the brain were eliminated. In cases of multiple sclerosis, there is sufficient disease of the eye to permit subjects to qualify for the present study. It is felt that a simple explanation of the eye conditions found in the tested subjects would be in order and of some benefit to non-medical persons interested in this survey.

a. Cataract- a cloudiness of the lens.

b. Central chorio-retinitis- is a chorio-retinitis involving the macula lutea or that portion of the back of the eye conceived with central vision.

c. Chorio-retinitis- an inflammation of the inner and middle layers of the eye.

d. Choroiditis - an inflammation of the middle layer of the eye.

e. Keratoconus- is a cone shaped protusion of the center of the cornea.

f. Opacity of cornea- a cloudiness of the cornea usually due to a scar from an injury, inflammation, or degeneration.

g. Optic atrophy- is a degeneration of the optic nerve.

h. Optic neuritis - an inflammation of the optic nerve.

i. Retinitis - an inflammation of the inner layer of the eye.

j. Retinitis Pigmentosa-is a familial degeneration of the inner layer of the eye manifested chiefly by night blindness.

APPENDIX II

VETERANS' APPRAISAL OF DEVICES

Case 1.[1] - The first veteran interviewed was 30 years old, had 20/200 visual acuity in both eyes. His deficiency was diagnosed as "loss of central vision due to bilateral macula degeneration with a small hole in the left macula." Three visits were made by this veteran; the first was made before the apparatus was organized and before data sheets were prepared. He was introduced to the various devices assembled without recording his reactions to them.

On his second visit he expressed a feeling that the No. 20 projection device did most to enable him to read, but on a basis of total convenience and need away from home, as well as at home, No. 5 was designated in preference to all others. Nos. 6 and 14 had also pleased him very much.

He returned six weeks later to confirm his original choice or to make another first choice. That time, instead of presenting 20 different magnifiers, we presented his first choice along with those he had previously found difficult to eliminate from first choice. Added to those were the balance of the eight magnifiers, most often selected as first choice by all of the veterans, not included in the array based on his choice.

He expressed satisfaction with certain characteristics of Nos. 5, 8, 14 and 20; when he finally picked No. 14 as first choice from the four, the act meant satisfaction with No. 14 in many ways but, it also meant that he had made concessions in certain characteristics not possessed by No. 14.

[1] Returned to confirm choice of magnifiers.

He gave up No. 5 because of its very small visual field, but he still liked its higher magnification and less bulk - hence easier portability. He was youthful, his eyes were bright and active without the usual empty, faraway stare of partially sighted persons. He simply wanted no impediments to attract attention to his blindness among people in the streets who didn't know.

He liked the lightness, magnification and visual field of No.8 but expressed an opinion that it was too bulky to carry in his pocket inconspicuously. As a check on the possibilities of correcting the cause of this complaint, the overall dimensions of No. 8 are effectively those of a cylinder $2\frac{1}{4}$ inches in diameter by 1 1/8 inches thick; the lenses in place without a holder are effectively a cylinder 1 3/4 inches in diameter by 5/8 inch thick. No doubt it is possible to design a holder satisfactory to him, for those lenses, that is less bulky.

The final choice of No. 14 was based largely, among other characteristics on its having lights of its own, yet it could be used without its own lights, and with the aid of a desk lamp, or with daylight properly incident. Further conditions of his first choice were that No. 20 must still be represented by the original wooden model, because when considering the Franklin Institute 5.0X, easy manipulated, metal cabinet model projector he liked it best for home use. However, the F.I. model was borrowed after the original tests were made and it was not officially included in our study.

Case 2. - This veteran was 23 years old. He had visual acuity of 5/200 in his right eye and could recognize fingers at one foot distance with his left eye. Diagnosis: "Bilateral primary optic atrophy".

To him it manifested itself as multiple scotoma or a visual field with numerous blind spots of irregular shapes which caused him not to see full words but perhaps the first letter and omit the second and third of a four, five or six letter work. This veteran's reading was therefore limited and reduced to reading one letter at a time out of the side of his right eye while remembering or creating an after image of what went before. His color perception was reduced to red, gray, black and white. In his condition Nos. 5, 6, and 20 rated at 3 as reading devices. He also preferred them in that order respectively in spite of the fact that the smallest type was read on No. 20.

Case 3. - A 40 year old veteran with 1/200 visual acuity in his right eye, the left eye was removed by enucleation. Diagnosis: "Patches of traumatic chorio-retinitis scattered throughout right fundus." His color perception reduced all stimuli to black or dark brown and white. He could not recognize enough details to read a single letter with any of the 20 devices. He correctly stated that a black and white photograph on a slick magazine page was that of a person. His best visual perception was from the side of his right eye.

Case 4.[1] - This veteran was 43 years old. He could perceive hand movements at one foot distance with his right eye and has 3/200 visual acuity in his left eye. His ophthalmic report included "Retinitis pigmentosa bilateral with optic atrophy left eye. Bilateral capsular cataract. Field of left eye limited to 2° radius about fixation point."

This veteran had normal color vision and rated the No. 19 device at 4, the highest with him for any reading device. He read 24 point type with it. On his return for confirmation of his first choice three

months later, he made no changes in his first choice among the original 20 devices, but he did say he liked the F.I. projector better than all the rest. He did not read smaller type with it. 30 point type was read with it alone and 14 point type by using 2.0X cylinder to separate letters.

Case 5. - This veteran was 61 years old. He had visual acuity of 2/200 in both eyes. His diagnosis was "Bilateral Keratoconus." He had normal color vision and scanned the whole visual field, even under the larger magnifying lenses. He rated magnifiers Nos. 19, 5, 20 and No. 1 as 5, 4, 4 and 3 respectively, all other devices ranked lower as 1 or 2 rating. His choice of No. 19 above No. 5 was based on the fact that he tired much more quickly in using No. 5 than when he used No. 19.

Case 6. - This was a 29 year old veteran, who had visual acuity of 20/200 and 7/200 in his right and left eyes respectively. His diagnosis was "Bilateral Optic Atrophy." His color perception was normal.

His description of his vision was as follows: "On sunshiny days I can see very well, but at dusk and on cloudy days everything looks blurry." He claims his condition was attributable to the flash from blank cartridges that were thrown into a camp fire while he was on training maneuvers. Other contributing causes he thought were due to being banged on the head by a truck. No. 19 and No. 6 were his first and second choices of magnifiers, they rated 5 and 4 respectively.

Case 7. - This was a veteran 33 years old. He had 20/200 visual acuity in both eyes. Diagnosis: "Bilateral Optic Atrophy."

He had normal color perception, but expressed a belief that his right eye was better than the left eye. He had a further medical history of psychogenic overlay superimposed upon multiple sclerosis.

He used a wheel chair as a paraplegic, and was not very steady with his hands. By straining he could read 12 point type at a distance of 8 inches without the aid of any glasses or magnifiers. Except for intermittent returns of a so-called "blind spot" he scanned the whole field under the largest magnifiers. On such occasions as when the blind spot appeared he would skip a word here and there or combine the first and last syllables of two successive words giving a strange continuation from ONCE MORE to ON-RE.

Magnifiers Nos. 19 and 17 rated 5 and 4 respectively with him, he liked all other less, but was able to read 6-10 point type with all devices except Nos. 1, 2, 3, 4, and 18, with those 18 point type was the smallest that he saw.

Case 8. - This veteran was 59 years old. His visual acuity was 90/200 and nil in the right and left eyes respectively. Diagnosis: "Thrombosis of central retinal vein with large vitreous exudates, right eye. Hyper mature cataract with posterior dislocation; tremulous iris with intense vascularzation of iris, left eye."

This veteran appeared to see fairly sharp outlines but very little detail. He seemed to have had use of the full field under the larger magnifiers. There was not a single reading device that enabled him to read satisfactorily when used alone. His final selection of No. 20 was made through the additional clarity and magnification added when he viewed the screen of No. 20 through the lens of No. 1, The

highest rating of any devices when used alone was 3, this was given to Nos. 1, 5, 6, and 14. Strangely enough he complained of glare from light reflected on to the screen of No. 20 when viewed alone and it rated a mere 1 without extra power of magnification given by No. 1.

Case 9.[1] - A World War I veteran, 50 years old, whose vision was expressed by "Hand movements at 13 inches" in both eyes. Diagnosis: "Central chorio retinitis with pre-retinal hemorrhage over foveal region, bilateral. At present receiving tuberculin therapy ..."

He claimed dizziness resulted from prolonged reading effort. Made two later visits five and six weeks spacing respectively. His best vision felt obtained from right eye when looking laterally towards the nose, "then it is clear but weak." The full moon was irregular outline like the silouette of an artichoke or an extra bumpy white potato. Lighted fluorescent tubes overhead seem tortuous and discontinuous rather than parallel.

Upon completion of the tests his first choice was bestowed on No. 18, but it rated only 3, the same as No. 19 and No. 20. His criticisms were No. 19 hurt his eyes with excessive light, No. 20 had sufficient enlargement but lacked enough contrast. No. 14 was too small in field and No. 5 was too much trouble picking out words one letter at a time. At a later visit the F.I. Model rated 5, he could read telephone book type 6 and 8 point. The best with others was 18-24 point.

Case 10. - This was a 31 year old veteran whose visual acuity was rated at 3/200 and 4/200 in the right and left eyes respectively. His diagnosis was "Bilateral choreo-retinitis, central." He was

unable to see smaller type than 24 points which he saw with No.6. Yet he liked No. 16 best and read only 48 point type with it. No. 5 had too small a field, could hardly see complete letter after magnification due to loss of central vision. He said letters on No. 20 didn't show up because the screen was too dark.

Case 11.[1] - This veteran was 38 years old, his visual acuity was 5/200 in both eyes. Diagnosis: "Optic atrophy, bilateral." This veteran was fluent in expressing the condition of his eyes as "no central vision." He reads from side of his eyes all the time, was red green blind. No. 5 rated 5 with him while No. 6 and No. 20 rated 4 and 3 respectively. He felt that No. 20 would hurt his eyes with prolonged use because of a lack of great contrast. No. 19 did not magnify enough for his use. No. 10 only good for distant viewing.

Case 12. - A 35 year old veteran. His visual acuity was 20/100 and 1/200 in the right and left eyes respectively. Diagnosis: "Bilateral chorio-retinitis, central." His right eye went bad when he was about 14 years old, it was the better of the two at that time. The left went bad in 1945. His best performance was with No. 20, rated 5, with which he read 7½ point type. The next highest rating with him, a 4, went to No. 16, with which 12 point type was read. Because of his curcumstances and personality, he has available readers, also a secretary and enjoys the company of congenial and well informed weekend guests who also read to him.

Case 13. - This veteran was 51 years old and had visual acuity of 20/200 in both eyes. His examination was recorded as:

"Optic Atrophy, Corneal opacity, posterior capsular cataracts retinal degeneration, tubular contracted visual field, bilateral." He gave best reading performance with No. 11 next No. 8 and No. 9, they rated, 5, 4, and 4 respectively. Lack of contrast in No. 20 was deplored; No. 16 best lens in Dartmouth frames; No. 19 pulled eye, outwards when reading with it. Could see more plainly with No. 19 than No. 16 but likes latter better.

Case 14.[1] - This was a 55 year old veteran who had 20/200 vision in his left eye and totally blind in the right eye. Diagnosis: "Optic atrophy, bilateral; color blindness for red, blue and green." This veteran sees centrally only. His best reading performance rated 5, and was with No. 20, preferably with overhead lights turned off. No. 6 was second best and rated at 4. The following magnifiers: Nos. 1, 5, 7, 8, and 14 rated 3.

The last time that he had read a paper was 8 years before. He could read 24 point type at 6 inches without glasses and 18 point type when ceiling lights were out. No strain was felt while using No. 20, but that was not true in regards to No. 6 which he liked next best. These magnifiers were rejected with reasons that follow: No. 2 had no effect on him or the letters, No. 5 had a very small field, Nos. 6, 8, and 14 were not clear. Most magnifiers were placed almost in contact with his left eye when using, that he felt shut out glare.

Upon his return visit for confirmation of his choice, no changes were made in relative ratings of the magnifiers. After re-

cording No. 20 as still his first choice, he was tested with the F.I. model while ceiling lights were out and without the hoods. That was liked even better than the Perkins projector.

Case 15.[1] - This veteran was 28 years old. "His left eye was enucleated, face spotted with discolored areas and scar tissue all caused by the explosion of a land mine." He had 20/200 vision in right eye. Diagnosis: "Right fundus showed extensive areas of old healed traumatic chorio-retinitis also involving macula with scars from choridal tear. Field constricted to20° visual angle."

This veteran chose No. 2 as his first preference among the magnifiers. He was a salesman for a securities and investment brokerage firm. His work required him to read newspaper stock quotations, both at home and while visiting customers' homes and offices. No. 2 was not entirely satisfactory, he wanted 50% more magnification, but in a single lens or a very thin combination. The rectangular shape, size and weight of No. 2 especially appealed to his desire for adequate field and ready availability from side of his jacket.

His criticism of other magnifiers follows: Nos. 5, 6, 7, 8 had too much magnification for his needs, No. 13 had too small a field but he liked the self lighting feature, No. 17 was of greater sharpness of focus than Nos. 16 and 18. No. 19 preferred to No. 20 because of lighting and in spite of relatively high magnification of No. 20 without sacrifice of field. In general he would sacrifice higher magnification in order to get a larger field to view. Ten weeks later he returned and confirmed his original first choice. Franklin Institute model did not suit his needs.

Case 16.[1] - A 32 year old veteran, whose acuity was 3/200 and 2/200 in right and left eyes respectively. Diagnosis: "Healed chorio-retinitis disseminated including central areas both eyes." This veteran had a visual field that was mostly black a few patches of sight at the periphery of the fixation point. H = I or 1 or I, I while W = V or V, V and U - T or T, T. None of the magnifiers rated 5 with him. No 18 did best with rating 3.

Case 17. - This veteran was 26 years old. He had 1/200 and light perception in his right and left eyes respectively. Diagnosis: "External strabismus and optic atrophy, bilateral."

This veteran performed best with No. 14 which rated 4 and next best with No. 17 also rated 4. He saw nothing on the screen of No. 20 due to lack of contrast. Nos. 5 and 8 revealed 18 and 14 point type respectively with rating 3 for their performance. He proposed a combination device composed of the field, light and stand of No. 19 combined with the magnification and clarity of No. 6 or No. 8.

Case 18.- This was a 28 year old veteran. His visual acuity was 10/200 and light perception in the right and left eyes respectively. Diagnosis: "Pendular nystagmus; bilateral optic atrophy; multiple sclerosis." He considered No. 4 as best for his purpose since he could satisfactorily read the newspapers with it. There were no differences apparent to him among the three lenses on Dartmouth stands. He offered the opinion that No. 11 was the worst magnifier.

Case 19. - This veteran was 36 years old and had 20/40 vision in both eyes. Diagnosis: "Retinitis pigmentosa, bilateral.

His visual field was constricted to a visual angle of 7° about the fixation point of central vision."

He liked No. 16, the plastic lens best among the lenses mounted in the Dartmouth frame and stands; could read anything by use of his spectacles, R.E. cylinder - .75 axis 180°; L.E. cylinder - .50 axis 180°, his acuity was measured with his glasses on. All magnifiers with wide fields suitable for binocular viewing appealed to him. Aside from No. 16 which received rating 5, all of the following wide lenses, Nos. 1, 2, 3, 4, 12, 17, 18, 19, and 20 plus small field types Nos. 5 and 16 received ratings of 4. The balance were rated at 3.

Case 20. - This veteran, age 31 years, had visual acuity of 10/200 in right eye and 20/30 in left. Diagnosis: "Traumatic central chorio-retinitis right eye. Color vision normal." This is one of the few cases where it was believed emotional stress, due to involvement in studies and exams prevented a subject from doing the best that he was capable of doing.

The test performances produced two ratings of 3, for magnifiers Nos. 7 and 18, all others rated 2. Attempts were made to have him return for a check run of tests but without success. Tests were performed under our handicap plan defined under test procedure when one eye is norm al.

Case 21. - A veteran of World War I, age 55, with 5/200 acuity in both eyes. Diagnosis: "Bilateral disciform degeneration of the macula." Color vision was normal. This is another case where the results obtained were less than the average for subjects in his acuity group. He did not admit to seeing any size of type up to and including 72 point bold. These results hold for all magnifiers.

Case 22.[1] - This subject was 57 years old and could barely see hand movements at 6 inches with both eyes. His diagnosis: "Bilateral cataract with optic atrophy. History of retinitis pigmentosa." He had a fair perception of blue and red. The results of the tests were summarized as follows: vision so meager that no type size, up to and including 72 point type, was intelligible to him. That holds for all magnifiers.

Case 23 - This subject age 55 barely sees hand movements with both eyes. Diagnosis: "Bilateral glaucoma with optic atrophy." His vision was so meager that he could not recognize 72 point bold letters with any of the magnifying devices.

Case 24. - This subject was 60 years old. His visual acuity was 10/200 right eye and 20/200 in left eye. Diagnosis:"Retinitis pigmentosa bilateral. Complicated cataract; glaucoma secondary, bilateral." Color vision normal.

Three visits were made by this subject. Each visit after the first was to check the reliability of his first choice. On the third visit he was loaned No. 14 for two weeks, the magnifier that he had consistently selected in preference to all others. With this subject the rating of 4 was given to Magnifiers Nos. 5, 10, 12, 13, and 18.

Some of his significant remarks about the magnifiers follow; with the aid of telescopic spectacles No. 10, he looked with surprise upon the features of his daughter, who had accompanied him, it was the first time in five years that he had seen any one with such clarity. He immediately implied a wish to use them to see his three year old granddaughter whose features he had never seen in detail.

When he returned the magnifier he reported the following experiences: this magnifier is very good for reading small amounts at a time on items like checks, bills and receipt or postcards, but no good for reading the newspaper - too tiring, he lost his place and used it flat on a table which strained his back and neck muscles. He read 15 minutes at a time, 4 or 5 times per day. He felt that it needed a handle, and an inclined support for the material.

Case 25. - This veteran was 29 years old. His visual acuity was 1/200 in both eyes. Diagnosis: "Optic atrophy, bilateral; left homonymous hemianopsia; encephalopathy, traumatic."

He stated that his condition resulted from flack that reached him while flying over enemy held territory during World War II. There was also a metal plate under the skin or scalp above the forehead and over the right eye. His sight in the left eye seemed better to him. His color vision was good for the primary colors. The only device with which he could see letters was No. 20 and it only rated 2, all others rated 1.

Case 26. - This veteran was 32 years old. His visual acuity was 20/100 right eye and 20/30 left eye. Diagnosis: "Bilateral iridectomy; bilateral glaucoma, trephine tension R = 49, L = 31 (Schiotz) optic atrophy right." Color vision was normal. His left eye was covered with a flap and gauze during the tests. No. 14 was his first choice of a magnifier and was rated 5. No. 19 ranked next best with a rating of 4. Others with a rating of 4 were Nos. 6, 7, 13, 15, 18 and 20.

He saw through a slit in iris located on the temporal side of the pupil of right eye. In trying to convey his impressions of what

occurred with that eye, he said, "when I am looking at a word it sometimes suddenly disappears. I start moving the magnifier about trying to find the word, then suddenly the sight returns and I realize that my sight had faded away for a short while."

He thereby justified the poor showing made by No. 5, it rated 2; because the small field and high magnification aided the words or letters in eluding him. He liked No. 14 best and could see the entire word ADVERTISEMENT in 12 point type without moving the magnifier.

Case 27. - This veteran was 62 years old. His acuity was 20/200 right eye, light perception with left eye. Diagnosis: "Trachoma, bilateral, chronic; marked scarring of cornea, bilateral with pannus."

This subject's performance with the magnifying devices was better than expected, based on previous tests with subjects having the same acuity. Assuming only minor discrepancies when acuities are recorded equal, other causes may be found to account for the higher performance among the items of the diagnoses, age and psychological state.

This subject found No. 8 the most satisfactory of all magnifiers and No. 14 next best. They were respectively rated 5 and 4. He preferred No. 8 because of its lightness relative to other magnifiers having the same field and magnification. Since he reads monocularly, he did not object to the smaller field; liked sharp black and white contrasts in field.

He placed No. 16 slightly higher in the relative scale than No. 17 or No. 18, though he could read 7½ and 10 point type with either.

He said No. 20 was perfect except for the "blue" background for the letters, he found that annoying even though he could read 5½ and 6 point type with it.

Case 28. - This subject was 29 years old. His acuity 20/50 right eye and 20/70 left eye. Diagnosis: "Macula degeneration, bilateral; chorio-retinitis, chronic, bilateral, central, color vision normal."

He preferred direct view magnifiers to the projection type, with which he read 5½ point size type. Nos. 6 and 8 ranked highest with ratings of 5 and 4 respectively. Cases like this in which a subject performs well enough, with all devices, point up the justification of allowing only one rating of five by any subject.

Case 29.- This subject was 64 years old and had 20/20 vision with correction in his right eye and light perception with his left eye. Diagnosis: "Bilateral iridectomy with aphapia. Right large patch of healed chorio-retinitis inferiorly; left-large retinal detachment."

This veteran rightly did not belong in the study because technically his best eye has normal acuity with correction and he cannot read at all with the other thus giving him a normal vision test, but considering his age and the complications of his diagnosis it was decided to include him for whatever his data would add to the study. He liked No. 13 better than he liked No. 14, and liked No. 16 best of 16, 17, and 18, because No. 16 gave straight lines (not distorted).

Case 30. - This veteran was 39 years old. His acuity 2/200 and 3/200 respectively in right and left eyes. Diagnosis: "Zonular cataract." He speaks of areas or spots of new vision in his field.

There were given as the reason for skipping letters or words occasionally. He places left eye (better with 3/200 close to the lens of No. 14 and uses half range focus.

His performance with the magnifiers was outstanding among the results obtained in his acuity group 1/200 to 3/200 (cf., case 5). Magnifier No. 14 ranked highest at 5 and No. 5 rated 4 as second choice. Six other magnifiers rated 4 with him they are Nos. 6, 7, 8, 9, 17, and 18. There were six magnifiers that rated 3 with him also. The only device that rated 1 in performance with him was No. 20. He prefers No. 7 to No. 9 (identical lenses) because No. 9 allows too much light to shine through.

Case 31. - This veteran was 60 years old. His acuity was 1/200 in the right eye and 10/200 in the left. Diagnosis: "Cataract, bilateral; diabetic retinopathy; color vision normal." He spoke of having several blind spots in his left eye.

Magnifier No. 8 was first choic and No. 14 was second. He also got good results with No. 5 and No. 6, both rated 4 the same as No. 14. The first choice was made among other things because the field allowed the subject to view two or more words at once. No. 5 was criticized because he only got good results with No. 5 and No. 6, both rated 4 the same as No. 14. The first choice was made among other things because the field allowed the subject to view two or more words at once. No. 5 was criticized because he only got a few letters when held at his best vantage point, which was about 3 inches from his left eye. No. 17 was less clear than Nos. 16 and 18. He disliked No. 20 called it "vague with no proper contrast between letters and screen."

Case 32. - This 44 year old veteran was blind in his right eye and was 1/200 in the left eye. Diagnosis: "Right - cataract and detachment of retina; left - cataract, glaucoma."

This veteran performed best with No. 14 and nearly as well with No. 11 both rated 2 and showed clearly no type smaller than 48 points. Magnifiers Nos. 1, 2, 3, and 4 cleared non smaller than 72 point type. None of the remaining magnifiers could do that well. His sight was obtained through a slit in nasal side of right iris.

Case 33.[1] - This veteran was 59 years old. He had light perception in his right eye and 20/200 in left eye. Diagnosis: "Bilateral plastic iritis; Left chorio-retinitis. Normal color vision."

This veteran was unsteady with his hands, consequently he could not manage very well with the higher power magnifiers which had small fields and resultant elusive images. His first choice was No. 17, it rated 5; his second choice No. 18 rated 4 the same as Nos. 3, 5, 6, 8, 10, 12, 13, 16, and 19.

Telescopic spectacles (No. 10) had a special appeal to him. A trip was made down to a street corner to test their usefulness in reading street names and traffic signals. Over head signs 10 to 12 feet above the street level were read at a distance of 8 or 10 feet from the signs. 18 point type was also read at 30 inches by use of telescopic spectacles without additional lens aid. By use of magnifiers Nos. 1 to 4 in addition to telescopic spectacles he could read 10 and 12 point type easily.

This subject made remarks about annoying and distracting orange colors at the edges of letters viewed under the lenses of Nos. 16 and

19, both are plastic lenses. No changes were made in his relative evaluation of magnifiers when he returned seven weeks later to check his first choice. He thought the Franklin Institute model was marvelous but his choice was made with an idea towards duplication as spectacles.

Case 34.- This veteran was 45 years old and had visual acuity of 20/200 with both eyes. Diagnosis: "Heredo - macular degeneration, bilateral. Normal color vision." His first choice was No. 14 which rated 5, his idea of best for home use. His second choice No. 5 rated 4 and was his idea of a good field magnifier. Ten other magnifiers besides his second choice rated 4 they were Nos. 6, 7, 8, 9, 10, 16, 17, 18, 19, and 20. 72 point type was read at from 24 to 36 inches distance without glasses or magnifiers. He suggested equipping No. 19 with green or amber shade-reflector, thought it would be more restful or less tiring.

Case 35.- This 40 year old veteran had 20/70 and 20/100 visual acuity in his right and left eyes respectively. Diagnosis: "Corneal opacities, bilateral, normal color vision." This subject could read 6 to 8 point type with any of the instruments including No. 10, telescopic spectacles, when used with a 2 power hand held magnifier.

Magnifier No. 6 was chosen best and No. 17 next best, with ratings of 5 and 4 respectively, all others except No. 10 were rated 4 also. This type of performance, where satisfactory reading could be and was done, with practically every magnifier, is the type of performance anticipated when we set up ratings allowing only one magnifier to receive rating 5.

Case 36. - This non-veteran was visiting the Franklin Institute in quest of the electronic pencil which he had heard about while studying at a theological school in California. From Franklin Institute , he got the impression that he would find it in a collection of prosthetic and development devices exhibited by the Veterans Administration in New York City.

We did not have the electronic pencil but since he had travelled so far seeking aid we agreed to allow him to see the magnifiers if he submitted to our screening and processing routine. Our findings through examination were supplemented by his statements, some remembered from famous American clinics. Diagnosis: "Central chorio-retinitis, bilateral; impaired color vision." Visual acuity 15/200 and 10/200 in right and left eyes respectively.

He read 6 to 8 point type with his first and second choice magnifiers, Nos. 20 and 5, those magnifiers rated 5 and 4 respectively. He read 30 and 36 point type with No. 14 which has 3.0X magnification and 24 point type with Nos. 1 to 4 which have 1.5 to 2X magnification. That discrepancy of reading smaller type with less magnification was explained by him, when confronted with the facts at the end of the tests, as due to inability of a small, deep lens system with higher magnification, to help a person with loss of central vision.

Case 37.[1] - This veteran was 56 years old and had 20/80 far and Jaeger No. 8 near vision in both eyes. The proper correspondence would be 20/80 and N. 10 or 20/60 and No. 8. In other words he had 70 per cent near vision perception and 58.5 per cent far vision or 21.6 per cent better near vision than far vision. Diagnosis: "Macular

degeneration, both eyes; contracted visual fields right 40°, left 45° about fixation point. Color vision poor."

This case offers a good example for comparison to Case No. 35 where the acuity is about equal but the visual deficiencies originate at different parts of the eye, the macular and cornea. This subject similarly selected magnifier No. 6 as first choice with rating 5, while only he chose No. 5 as second choice with rating 4. He performed with only four other magnifiers well enough to rate them 4 also, they were Nos. 7, 8, 9, and 14.

His second visit for confirming first choice was marked by his continued selection of No. 6 as first choice, the Nos. 20, 5, and 8 were serious contenders. No. 6 was a compromise between Nos. 5 and 8 because both the field and magnification of No. 6 were between those of the contenders Nos. 5 and 8.

Case 38. - This veteran was 32 years old. He had normal vision in his right eye and 10/200 in the left eye. Diagnosis: "Corneal opacity, left; normal and color vision."

His right eye was covered during the tests in order to assimilate conditions existing with persons having total vision no better than 10 / 200. With that handicap he selected No. 20 as first choice with rating 5 and No. 6 as second with rating 4; seven other magnifiers rated 4 they were Nos. 5, 7, 8, 9, 14, 18, and 19. It was interesting to note that he read 18 point type with No. 18 while 24 and 30 point type was the best with Nos. 16 and 17 respectively.

Case 39.- This veteran was 35 years old. His visual acuity was 20/200 in the right eye and 20/400-20/20 left eye. Diagnosis:

"Complicated cataract left eye; normal color vision." This veteran performed the tests with his left eye covered to assimilate conditions of 20/200 vision or less. No. 13 magnifier pleased him best and was rated 5; No. 8 was next best with rating 4; all others received rating 4 except Nos. 10, 11, and 19 all of the latter cleared 18 and 24 point type, No. 19 was thought to have too much light; Nos. 1 through 5, 12, 15 through 17 had glare.

Case 40.[1] - This veteran was 24 years old and had visual acuity of 5/200 both eyes. Diagnosis: "Optic atrophy, bilateral; Red-Green blindness." This subject selected magnifiers No. 5 and No. 8 rated at 4 and 3 as first and second choices respectively; he made out fairly well with No. 6. Magnifiers Nos. 1, 2, 3, 4, and 11 rated 2, all remaining rated 3.

On his return the relative ratings were unchanged but the F.I. Model brought his performance up to a 5 rating.

Case 41. - This veteran was 39 years old. He had normal vision in his left eye and 20/50 in the right eye. Diagnosis: "Degeneration scarred area in right macula; central chorio-retinitis, right eye. Normal color vision."

This subject performed the tests with his left eye covered in order to assimilate 20/50 total vision. Thus handicapped he read 6, 8, and 10 point type with every magnifier except No. 10, the telescopic spectacles. His first two references go to Nos. 16 and 17 respectively, they rated 5 and 4 in the same order. All others rated 4 except No. 10.

Case 42.[1] - This 41 year old veteran had light perception in

both eyes. His condition diagnosed as "Optic atrophy. Color vision too poor to take note." He was a subject at Avon in 1947 when the Perkins Institution conducted similar tests there in Connecticut at the Old Farms Convalescent Hospital.

This subject was not successful in reading smaller than 24 point type; that was read with the Franklin Institute 5 power magnifier, the Perkins projection magnifier did not offer enough brightness in background or contrast. Magnifier No. 14 rated 3, the highest of the regular 20 devices, Nos. 16, 17, and 18 rated 2 and all the rest rated 1.

Case 43.[1] - This veteran was 39 years old and was entirely blind in the right eye with 4/200 in the left eye. Diagnosis: "Corneal opacities- bilateral." He performed best by using Magnifier No. 8, with which he read 18 point type, his next best performance was when using No. 5, with which he read 24 point type. They received ratings of 4 and 3 respectively. Magnifiers Nos. 10, 11, and 20 received ratings of 1, all others were rated at 2.

Case 44.[1] - This 37 year old veteran had normal vision in his right eye and 20/100 in his left eye. His condition was diagnosed: "Vitreous floaters left eye; early frost capsular cataract left eye. Normal color vision." His best performance was made while using magnifier No. 14 which was rated at 5, his next best was with No. 5 which was rated at 4. Twelve rated at 3 and 4 magnifiers rated 2 leaving 2 which rated 1.

Supplementary Case I = Case 36

Supplementary Case II

This subject accompanied a veteran who took the tests. Because her acuity, 20/300 both eyes, was within the range we were interested in, we took data on her performance also. Diagnosis: "History of congenital cataract, brother was only other member of family known to have cataract. Color vision normal."

Her best performance was with magnifiers Nos. 5 and 14 of the original 20 magnifiers. They rated 5 and 4 respectively by clearly revealing 10 and 12 point type to her. Her later tests with the Franklin Institute model showed 5½ and 6 point type clearly. Her reaction was to prefer its results to the others, but when considering its usefulness to her, a regularly employed typist of dictaphone recordings, she felt that correcting or reading her typed material required something more like No. 5 or No. 14 so the relative ratings stood as before.